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Auction agent | Google Search

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Searched the web for **Auction agent**. Results **1** - **10** of about **461,000**. Search took **0.35** seconds.

Categories: Business > Major Companies > Publicly Traded Computers > Software > Internet > Clients > WWW > Utilities

Welcome to MLB.com **Auction**
... Get an **Agent** Save time by letting our **Auction Agent** do the work. Receive emails when items you want go on the block. Watch It Not quite ready to bid? ...
auction.mlb.com/ - 31k - Cached - Similar pages

Perl implementation of the **Auction Agent** Protocol for AuctionBot
Perl implementation of the **Auction Agent** Protocol for AuctionBot. There are only two functions that are needed to communicate with the AuctionBot. ...
auction2.eecs.umich.edu/auction/abii_docs/ pub_dist/api/perl_api.html - 7k - Cached - Similar pages

www.agent-x.de/
Similar pages

Servers
... Services. **Auction agent**. **Auction** Watch list. Terms. Fees. ... Can't find it? Try the **Auction Agent**! Narrow Your Search. Picture Hot Merchant **Auction** Reserve Dutch. ...
auctions.bcentral.com/HTML/Cat35754/ Page1.htm?CatNo=206 - 33k - Cached - Similar pages

Cash Registers
... My bCentral Services. Services. **Auction agent**. **Auction** Watch list. Terms. Fees. ... Can't
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auctions.bcentral.com/HTML/Cat55104/ Page1.htm?CatNo=3321 - 35k - Cached - Similar pages
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Napa Group, Inc.
», demonstration. **auction agent** software, DART, ... Then, I can print the report, or email it directly to anyone on my contact list." -- JC, **Auction Agent**. ...
www.napa.com/AuctionAgentSoftware.asp - 11k - Cached - Similar pages

My Account Help
Auction Agent is a utility designed to assist you in locating items that you specifically seek. Set up an **Auction Agent** and Submit ...
auctions.virgin.net/Scripts/MyAccountHelp.asp?sec=4 - 4k - Cached - Similar pages

Help for Buyers
... Use **Auction Agent**. **Auction Agent** is a utility designed to assist you in locating items that you specifically seek. Set up an **Aucti n** ...
auctions.virgin.net/Scripts/ Buying.asp?sec=Tips+%26+Hints - 7k - Cached - Similar

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Fact Sheets
... **Auction** agency agreement: the **agent** organises the **auction** of your home.
The most common agreement signed is an Exclusive agency agreement. ...
www.domain.com.au/TV/content/ha4_factsheet2.html - 10k - Cached - Similar pages

CompUSA Auctions
... Sign Up Now! My **Auction** Account **Auction Agent** FAQs Customer Service Terms and Conditions
Privacy Policy. ... Try the **Auction Agent** or you can refine your search... ...
compusaauctions.com/Scripts/ LotSearch.asp?submitFlag=1&SearchSiteNo=946 - 44k - Cached - Similar pages

Gooooooooooogle ▶
Result Page: 1 2 3 4 5 6 7 8 9 10 **Next**

Auction agent | Google Search | Search within results

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Auction Agent Sample

Auction Agent Makes finding the most auctions on the product you want easy.

Type in your product and Auciton Agent goes to Yahoo,Ebay,Amazon,Lycos, and FirstAucion.

Using CFHTTP Auciton Agent then returns the number of items for auction at each site.

Current Version: 1.1 Atributes allow you to:

- Turn off some selected searches.
- Change the search box size.
- Change the html search button value.
- Add a image file for the search button.
- Open the auction link in a new window.

Sample Tag format for the above sample.

```
cf_AuctionAgent
        BoxSize="50"
                SrchBtnAlt="GetResults"
                        NewWin="1"
```

Type your search here:

Search

PayPal ADD TO CART View Cart

Buy The UNENCRYPTED Tag Now!

JUST 5.00!!!

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Auctions portal : auctions guide and **auction** search **agent** to ...
... will find items for you at ebay,amazon and yahoo auctions.Auctions portal is the most comprehensive Online **Auction** directory and **auction** search **agent** on the ...
www.auctions-portal.com/ - 46k - Cached - Similar pages

AJ's World Stamp Dealers Index Terminology
... Usually denoted in indexes with the PLUS symbol (+), the term '**Agent**' or 'Acency'. cf '**Auction Agent**'. Master List of Postal Agents. **Auction Agent**. ...
wardaj.tripod.com/i/localdlr/xref/terms.htm - 12k - Cached - Similar pages

Real Estate Australia - Property for sale lease and rent online ...
... content included when available.**); The selling **agent** is listed for all reported auctions and where available in private treaty sales. **Auction** results (where ...
reports.realestate.com.au/products/homepriceguide/ index.cfm?source=realestate - 34k - Cached - Similar pages

Real Estate Australia - Property for sale lease and rent online ...
... included when available.**); The selling **agent** is listed for all reported auctions and where available in private treaty sales. All **auction** results (where ...
reports.realestate.com.au/products/ street/index.cfm?source=realestate - 40k - Cached - Similar pages
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>> Domain Mart - Domain Name Appraisal, Buy/Sell, Broker, Escrow ...
Domain name and business broker/**agent**, appraisal, **auction**, buy, sell, escrow, registration
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Description: Register, monitor, and protect your domain name.
Category: Computers > Internet > Domain Names > D
www.domainmart.com/ - 16k - Cached - Similar pages

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... 1. Check out Advanced search. Search Tips. Refine Your Search, Can't find it? Try the **Auction Agent**! All **auction** end times in Eastern Standard Time (EDT). ...
auction.newline.com/Scripts/ LotSearch.asp?SubmitFlag=1&S=ClosingSoon - 20k - Cached - Similar pages

[PDF]Probabilistic Automated Bidding in Alternate Auctions
File Format: PDF/Adobe Acrobat - View as HTML
... Experimentation **Auction** simulation platform Analyser Results **Aucti n** House Local Bidding **Agent Agent** Bidding Probabilistic Java RMI **Auction** 3 **Auction** 2 **Auction** ...
www2002.org/presentations/dumas.pdf - Similar pages

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Nomad:Mobile **Agent** System for an Internet-Based **Auction** House
March/April 2000 (Vol. 4, No. 2). pp. 80-86 Nomad:Mobile
Agent System for an Internet-Based **Auction** House. ...
www.computer.org/internet/ic2000/w2080abs.htm - 9k - Cached - Similar pages

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... OF SALE printed in our **auction** catalogues constitute our agreement with the buyer
at **auction**. ... If you are acting as **agent** for some other party who does not sign ...
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Searched for **http://www.auctionrover.com** **29** Results

Note some duplicates are not shown. See all.
* denotes when site was updated.

Search Results for Jan 01, 1996 - Jul 23, 2003

1996	1997	1998	1999	2000	2001	2002	2003
0 pages	0 pages	0 pages	2 pages	14 pages	3 pages	5 pages	0 pages
			Nov 27, 1999 *	Feb 26, 2000 *	Mar 08, 2001	Jan 20, 2002	
			Nov 28, 1999	Mar 02, 2000 *	Apr 05, 2001	Jan 25, 2002	
				Mar 02, 2000 *	Sep 25, 2001	May 27, 2002	
				Mar 03, 2000		Jun 01, 2002	
				Mar 03, 2000 *		Jun 06, 2002	
				Mar 04, 2000			
				Mar 06, 2000 *			
				May 20, 2000 *			
				Jun 19, 2000 *			
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Ebay Great Collections Hosts Auctions of 36 Millennium Dresses by World's Top Fashion Designers
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Ebay Launches Ten More City Sites
New York, Chicago, Detroit, Phoenix, San Diego, Indianapolis, Columbus, Oklahoma City, Austin and Raleigh-Durham get their own eBay auction sites.

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As a result of an agreement reached between eBay and AuctionRover.com, we will be redesigning our search feature to provide access to complete eBay search results.

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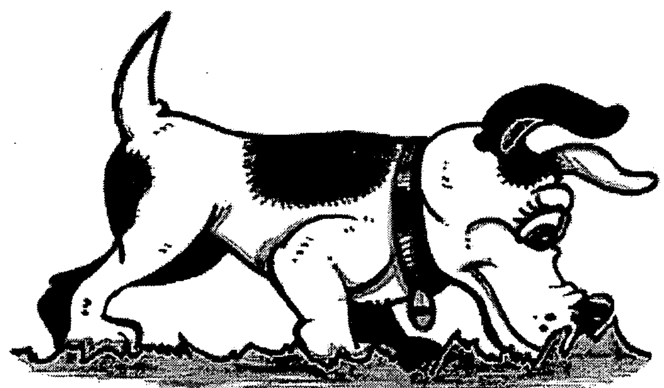

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Our Directory list online auctions with categories links to auctions and news:

- **Antiques**
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eBay auctions

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- **Computers**
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Auctions worldwid

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More and more auctions are coming online everyday.eBay has now new site design :-) We will try to spotlight some **of the news and st ck prices on the Online Auctions in our "News"** listing and show you some interesting News and links on Online Auctions topic.

Search: Search

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email us Computers Newsletter Top Ten Best Price Link to us Friends

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Jewelry, Gemstones
Miscellaneous
Photo & Electronics
Pottery & Glass
Sports Memorabilia
Toys, Bean Bag Plush

Amazon Auctions FAQ (7)
Learn all you need to know to navigate Amazon Auctions.

Auction Formats FAQ (7)
Not all online auction is the same. Educate yourself on auction formats with our comprehensive format FAQ.

Beginner's FAQ (6)
All you ever wanted to know but never knew who to ask about online auctions.

Bidder FAQ (9)
Learn how to get the goods you've always wanted by bidding at online auctions.

eBay FAQ (7)
AuctionRover's step-by-step guide to getting started at eBay.

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Answers to questions about creating and using Electrifier shows in your auctions.

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Auction Watch list
Terms
Fees
Questions & Comments

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Real time results from eBay TM, Amazon.com TM and Yahoo! TM auctions

Price comparison AGENTS search trough online auction (or any other online stores) databases internet and compare prices for items that you are looking for..

Among other programs who search online stores, vendor sites and classifieds and may vary in their thoroughness. Most do a better job of finding and comparing computer and related products.

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- Auction Watchers A new web site that lists all items from Auction World, DealDeal, Ubid, Onsale, WebAuction and Surplus Auction on one site. Auction Watchers also displays real time updated information on the site. So users can see what the current bid is needed to win each item .
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- BidSmart BidSmart **was** a service provided by Stephen Oskoui and Thai Tran, two students at Stanford University.
- BottomDollar A great products pricing agent. Compare prices at various online stores and malls... Recommended.
- Jango product finder from Excite
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The Michigan Internet AuctionBot: A Configurable Auction Server for Human and S ftware Agents (1998) (Make Corrections) (88 citations)

Peter R. Wurman, Michael P. Wellman, William E. Walsh

Proceedings of the 2nd International Conference on Autonomous Agents (Agents'98)

Abstract: Market mechanisms, such as auctions, will likely represent a common interaction medium for agents on the Internet. The Michigan Internet AuctionBot is a flexible, scalable, and robust **aucti n** server that supports both sofware and human agents. The server manages many simultaneous auctions by separating the interface from the core **auction** procedures. This design provides a responsive interface and tolerates system and network disruptions, but necessitates careful timekeeping procedures to ensure ... (Update)

Context of citations to this paper: More

.... **bw=50 (right) 6 Related Work Auctions are becoming the predominant mechanism for agent mediated electronic commerce [12] AuctionBot [32] and eMEDIATOR [26] are among the most well known examples of multi agent auction systems.** They use economics principles to model the...

.... **architectures limit the interactions of agents to manual negotiations, direct agent to agent negotiation [22,8] r some form f auction [27].** Auctions are becoming the predominant mechanism for **agent** mediated elec tronic commerce [11] AuctionBot [27] and eMEDIATOR [21] are...

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Risk and Expectations in a-priori Time Allocation in - Multi-**Agent** Contracting.. (Correct)
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0.6: The Michigan Internet AuctionBot: A Configurable **Auction**.. - Wurman, Wellman, Walsh (1998) (Correct)
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1.1: Control Architecture for a Flexible Internet **Auction** Server - Wurman, Wellman, Walsh.. (1999) (Correct)
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28: Auctions and Bidding (context) - McAfee, McMillan - 1987
23: **Agent**-mediated electronic commerce: a survey (context) - Guttman, Moukas et al. - 1998
18: Multipart Pricing of Public Goods (context) - Clarke - 1971

BibT X entry: (Update)

P.R. Wurman, M.P. Wellman, and W.E. Walsh. The Michigan Internet AuctionBot: A configurable **auction** server for human and software agents. In Second Int'l Conf. on Autonomous Agents, May 1998. http://citeseer.nj.nec.com/wurman98michigan.html
More

```
@inproceedings{ wurman98michigan,
    author = "Peter R. Wurman and Michael P. Wellman and William E. Walsh",
    title = "The {Michigan Internet AuctionBot}: {A} Configurable Auction Server for Human and S
    booktitle = "Proceedings of the 2nd International Conference on Autonomous Agents (Agents'98
    month = "~9--13,",
    publisher = "ACM Press",
    address = "New York",
    editor = "Katia P. Sycara and Michael Wooldridge",
    isbn = "0-89791-983-1",
    pages = "301--308",
```

```
    year = "1998",
    url = "citeseer.nj.nec.com/wurman98michigan.html" }
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Citations (may n t include all citati ns):

163 A market-oriented pro- gramming environment and its applicat.. - Wellman - 1993
147 Kasbah: An **agent** marketplace for buying and selling goods - Chavez, Maes - 1996
128 Auc- tions and bidding (context) - McAfee, McMillan - 1987
81 **Agent**-mediated electronic commerce: A survey (context) - Guttman, Moukas et al.
77 Market-Based Control: A Paradigm for Distributed Resource Al.. (context) - Clearwater - 1995
59 Social informa- tion filtering: Algorithms for automating 'w.. - Shardanand, Maes - 1995
51 Auctions and bidding: A primer (context) - Milgrom - 1989
47 Flexible double auctions for electronic commerce: Theory and.. - Wurman, Walsh et al. - 1998
43 An economic paradigm for query processing and data migration.. (context) - Stonebraker, Devine et al. - 1994
38 MAGMA: An **agent** based virtual market for electronic commerce - Tsvetovatyy, Gini et al. - 1997
31 The Dou- ble **Auction** Market: Institutions (context) - Friedman, Rust - 1993
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10 **Auction** institutional design: Theory and behavior of simulta.. (context) - McCabe, Rassenti et al. - 1990
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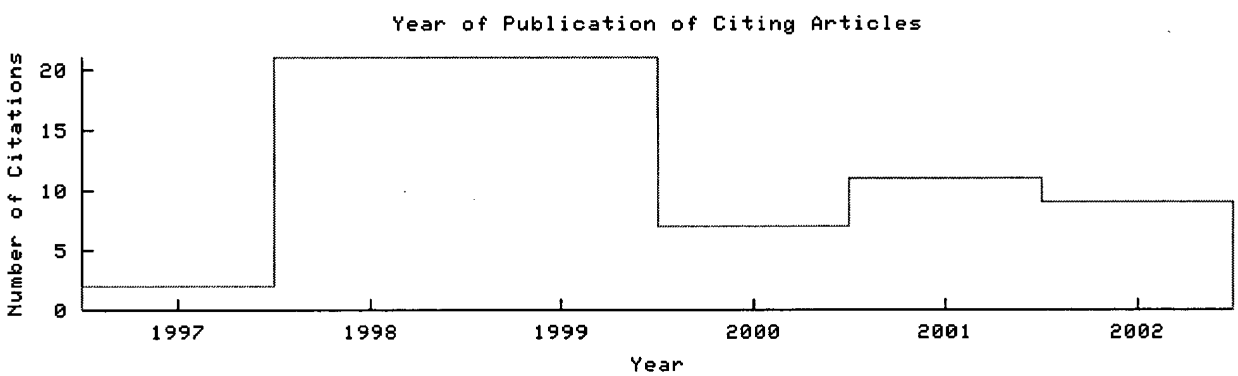

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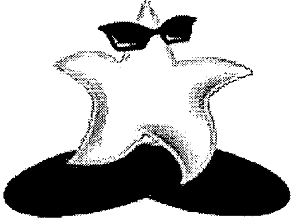

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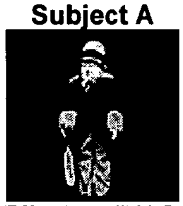
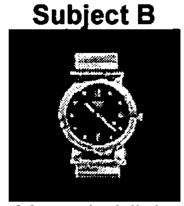


Effanbee "W.C. Fields" Doll Legendary Series

Subject B



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TOP TEN

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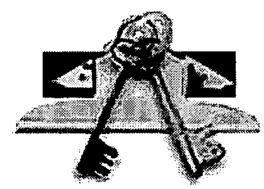

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- **Toys & Games** (40)

Intelligent Agents

Schedule:

Course: Wednesday 15-17, INR 219
Exercises: Wednesday 17-18, INR 219

The main topic of this course are technologies for implementing *intelligent agents*. Agents differ from conventional (object-oriented) software technology in one or more of the following 4 dimensions:

1. *autonomy*: agents react themselves to observations of their environment without requiring explicit commands,
2. *proactiveness*: agents recognize and react to changes in the environment which present opportunities,
3. *embeddedness*: agents' actions respect the real-time constraints imposed by the environment,
4. *distributedness*: many different kinds of agents can work together in the same system, and be added or removed without interrupting it.

Beyond these basic characteristics of agent technology, agents are likely to become more *intelligent*:

1. *rational* agents which have explicit goals and reasoning capabilities, thus giving them the ability for self-interested action,
2. *communicating* agents which can cooperate and negotiate using powerful agent communication languages,
3. *adaptive* agents which learn by themselves to fulfill their user's desires, or to react or survive in their environment,
4. l*earning* agents which are capable of improving their performance on the same task by reusing earlier experiences.

The course builds on existing knowledge in AI and develops in particular the notions of autonomous and embedded behavior by focussing on electronic commerce scenarios where these are most actively used today. It will introduce adaptativity and learning into this context. Finally, we will consider technologies for implementing heterogeneous agent systems with general communication capabilities.

Exercises:

A centerpiece of this course will be the exercises, centered around e-commerce scenarios. An important immediate application of intelligent agents is for negotiation of business transactions in deregulated markets such as travel, communication or electricity. These negotiations happen through auctions involving automated buyer and seller agents. The exercises in this course will gradually develop an intelligent buyer agent in the travel domain. They require programming in Java and networking with an electronic marketplace. At the end of the course, agents will compete and the most successful ones will be given a chance to participate in a world-wide competition held at the 4th International Conference on Multi-agent sytems, Boston, July 2000.

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Course Program:

27.10. What is an intelligent agent? Basic elements of agent technology (slides)

3.11. Theory of self-interested (autonomous) agents; Game-playing agents (slides)
Exercise 1: game-playing agent

10.11. Agents in electronic commerce and auctions (slides)
Exercise 1

17.11. Auction platforms (slides)
Guided demo: Michigan auction platform

24.11. Reasoning with limited resources (slides)
Exercise 2: simple auction agent (optional: reinforcement learning) compitition

1.12. Negotiation and cooperation frameworks, contract nets (slides)
Exercise 2

8.12. Efficient planning algorithms using constraint satisfaction (slides)
Exercise 3: combined auctions with lookahead/optimization

15.12. Distributed constraint satisfaction(slides)
Exercise 3

22.12. Agents using case-based reasoning(slides)
Exercise 3

12.1. Beliefs/Desires/Intentions: formal models of agent behaviors (slides)
Exercise 4: combined auctions with learning

19.1. Agent communication languages: KQML/ACL(slides)

26.1. Ontologies (slides)
Exercise 5: auction agent competition

2.2. Agent platforms (slides)

9.2. Mobile agents

An auction agent for bidding on combinations of items

Full text Pdf (179 KB)

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ABSTRACT

This paper describes a way to obtain sub-optimal profits in bidding for combinations of goods that are on auction at different sites, and results for an autonomous agent that bids for goods according to the proposed strategy. The types of requirements for combinations are classified as complementary, substitutive and independent. For each type, this paper specifies the region in which bidding on goods will make a positive profit. A bidding strategy is then proposed for sequential auctions under the condition that the bids by the other participants in the auction can be represented by a probabilistic function. Two simulations were constructed to evaluate the proposed strategy. They indicated that the agent that applies the proposed strategy was superior to others that bid for combinations of goods according to simple and intuitive strategies. The simulations also indicated that the proposed strategy was the equilibrium strategy of those we tested, when two agents were simultaneously bidding for the same combination of goods.

REFERENCES

Note: OCR errors may be found in this Reference List extracted from the full text article. ACM has opted to expose the complete List rather than only correct and linked references.

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↑ INDEX TERMS

Primary Classification:

I. Computing Methodologies

↪ **I.2** ARTIFICIAL INTELLIGENCE

Additional Classification:

F. Theory of Computation

↪ **F.2** ANALYSIS OF ALGORITHMS AND PROBLEM COMPLEXITY

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An Auction Agent for Bidding on Combinations of Items

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ABSTRACT

This paper describes a way to obtain sub-optimal profits in bidding for combinations of goods that are on auction at different sites, and results for an autonomous agent that bids for goods according to the proposed strategy. The types of requirements for combinations are classified as complementary, substitutive and independent. For each type, this paper specifies the region in which bidding on goods will make a positive profit. A bidding strategy is then proposed for sequential auctions under the condition that the bids by the other participants in the auction can be represented by a probabilistic function. Two simulations were constructed to evaluate the proposed strategy. They indicated that the agent that applies the proposed strategy was superior to others that bid for combinations of goods according to simple and intuitive strategies. The simulations also indicated that the proposed strategy was the equilibrium strategy of those we tested, when two agents were simultaneously bidding for the same combination of goods.

Categories and Subject Descriptors

I.2.8 [**Artificial Intelligence**]: Probrem Solving, Control Method, and Search; K.4.4 [**Computers and Society**]: Electronic Commerce; F.2.2 [**Analysis of Algorithms and Probrem Complexity**]: Nonnumerical Algorithms and Probrems

General Terms

Economics, Design, Experimentation

Keywords

Auction, autonomous bidding agent, bidding strategy, combination issue

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1. INTRODUCTION

The number of electronic auction sites on the Internet has greatly increased in recent years. Many people enjoy joining the thrilling battle over the prices of attractive goods on such sites. It is also true that some people are motivated by the feeling of satisfaction at winning the game after a price battle against opponents who have their own special strategies. People also join these auctions simply because they hope to buy goods cheaply and to sell goods at a high price. There are, however, so many auction sites dealing with so many different items on the Internet that it is impossible for bidders to monitor all of the relevant sites and find the best prices for desired items. Both commercial and academic groups have attempted to reduce the effort involved in periodical monitoring by bidders. eBay [3], which is perhaps the most famous on-line auction site provides an automatic bidding agent, in which the bidder sets a maximum amount that he or she is willing to pay for an item. The agent then automatically raises the bid until the bid has exceeded all of the other bids or reached the maximum amount. AuctionBot [9], which is a research-oriented auction site, supports Vickrey auctions; that is, auctions of the 'second-price sealed' type, in which the bidder sets a maximum amount that is sealed from the others, as in the eBay auction, and the bidder who places the highest bid wins the item but pays the second highest price. Both agents work quite well in terms of reducing the effort required of the bidder in monitoring the price of a single item that is up for auction, but do not work with multi-item auctions.

The Federal Communication Commission (FCC) has used a unique system for assigning electromagnetic spectrum licenses since 1994. A type of auction called a simultaneous multiple-round auction [1] is used, in which a bidder simultaneously bids on multiple items that may complement each other. For example, a bidder who wants two complementary licenses may simultaneously bid for both licenses. The bidder is encouraged to keep bidding for both licenses, since a single license would be worthless to him, even if the prices of the licenses as individual licenses become excessive. To reduce the risk involved, the bidder has the right to retract his highest bid, if in the end he wins only one of the items, but this incurs a penalty. This type of simultaneous multiple-round auction has worked well, but it is simply an auctioneer-side solution that allows bidders to apply for multiple items at an auction managed by a single auctioneer. Therefore, another approach must be examined for bid-

ders who want to bid for multiple items at separate auctions managed by separate auctioneers.

Sandholm has developed algorithms for determining the optimal winning bid in a combinatorial auction, i.e., a single auction in which bidders may place bids for combinations of items, in such a way that the bidders do not have to speculate on the values of the individual items [7, 6]. He made it clear that the determination of optimal winning bids for this type of auction was an NP-complete problem, and, on this basis, proposed approximate 'anytime' algorithms for its solution. This approach is beneficial to bidders who want to get complementary goods at an auction, but it only applies to combinatorial auctions at which all items are at the same site. Since the multiple items that we require will most often be on various web sites that are managed according to different policies, approaches that only apply to such consistently managed auctions will not be realistic in many cases.

This paper describes an approach to bidding in multi-site multi-item auctions at which no auctioneer-side effort goes into the combination of complementary items. In this situation, a bidder-side scheme for the placement of the appropriate bids at the various sites is required. This setting, which is described in more detail in the next section, is more realistic than those used in other research on multi-item auctions. The approach described in this paper is to analyze the conditions under which a bidder who wants to get a combination of goods becomes able to win all of the required auctions, and to create a strategy around a probabilistic estimate of the satisfaction of the conditions. Multi-item auctions of three types are defined in section 2 in terms of the bidder's preferences. We refer to these types as complementary, independent and substitutive, and analyzes their profits on the basis of the clearing prices of the items. Section 3 describes our analysis of sequences of auctions on the basis of a probabilistic model, that results in a strategy to guide the bidder in whether or not to keep raising a bid. In section 4 we describe the simulation-based verification of our approach. Comparisons with other auction-related research are given in Section 5.

2. PROFIT ANALYSIS FOR THE THREE POSSIBLE SUCCESSFUL COMBINATIONS

Internet auctions usually take the form of single-item auctions, in which each item is auctioned separately. However, a bidder might require two separate items that are on auction at different sites, either of which is worthless to the bidder. Such a requirement is called 'complementary'. On the other hand, a bidder might want to get either of two items but not require both of them. This is called a 'substitutive' requirement. Finally, a bidder might want to get two items with no particular preference, but have a limited total budget. Such a requirement is referred to as 'independent'. It is then possible to classify the types of preferences for combinations of items into the three types described above.

In this paper, it is assumed that the bidder's profit is quasi-linear. That is, when the bidder wins the item, the profit is the difference between the clearing price and the value of the item to the bidder, while the profit is zero if he does not win the auction. The profit on combinations of items can then be calculated. For example, when two complementary items X and Y are required, the profit gained by winning the two items is the difference between the total price for X and Y and the value of the two in combination, V_{xy}. Items X and Y also have values to the bidder as individual items, V_x and V_x. The profit if the bidder wins on the item X but loses on the item Y is the difference between the price of X and V_x. Figure 1(a) to 1(c), shows the regions in which the profit on two items is greatest when both items, either item, or neither item is obtained. In these figures, the horizontal axis represents the price of X, x, and the vertical axis represents the price of Y, y. T is the total budget. 'X' marks the region in which the bids on X produce the greatest profit if successful, 'Y' marks the region in which the bids on Y produce the greatest profit if successful, 'X+Y' marks the region in which the bids on both X and Y produce the greatest profit if successful, and Area ϕ represents the region in which it is best not to bid.

In Fig. 1(a), which represents the case of complimentary goods, successful bidding on both X and Y produces the greatest profit as long as the sum of the current prices of X and Y is less than the value of X and Y ($x + y \leq V_{xy}$) as a combination. On the other hand, bidding on either item produces the greatest profit as long as the profit obtained by the successful bid on either X or Y is greater than the profit obtained by the bid on both X and Y; that is, in the case of X, $x \leq V_x$, $V_x - x > V_{xy} - x - y$, and in the case of Y, $y \leq V_y$, $V_y - y > V_{xy} - x - y$. On the border of the union of these three regions, the profit is zero, and within the region in which it is best not to bid, any of the three possible types of successful bid will result in a loss.

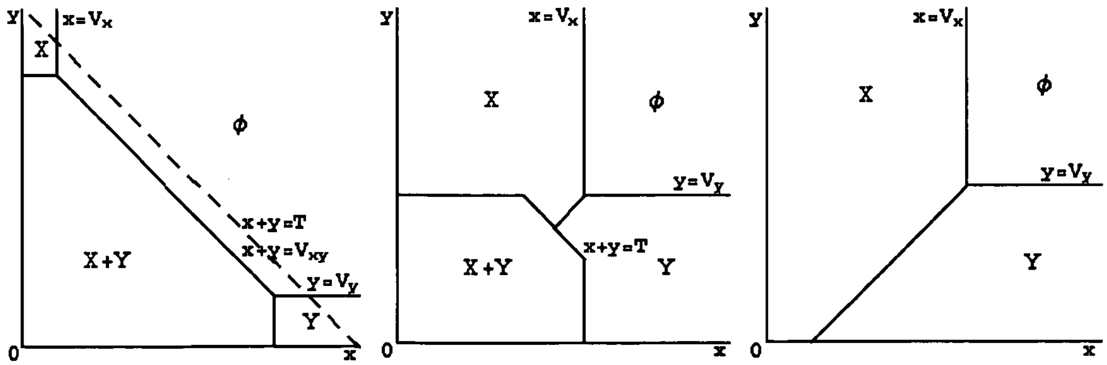
In Fig. 1(b), which represents the case of a requirement for a combination of goods of the independent type, bidding on both items produces the greatest profit (of the three possible successful outcomes) as long as the current prices of both X and Y are less than their respective values, and this result is only possible as long as the sum of the bids is less than T, that is, $x \leq V_x \wedge y \leq V_y \wedge x + y \leq T$. On the other hand, successful bidding on either of items produces the greatest profit as long as the price of the item is less than its value and the sum of the prices is greater than T; that is, for X, $x \leq V_x \wedge V_x - x > V_y - y \wedge x + y > T$, and, for Y, $y \leq V_y \wedge V_y - y > V_x - x \wedge x + y > T$. In Fig. 1(c), which represents the case of a requirement for goods of the substitutive type, the profit is greatest for a successful bid on X when $x \leq V_x \wedge V_x - x > V_y - y$ and for a successful bid on Y when $y \leq V_y \wedge V_y - y > V_x - x$.

The above analysis is only of practical value when the clearing prices are known, and this assumption is, of course, unrealistic. A more practical analysis, in which the probabilistic distribution of clearing prices is known, is presented in the next section.

3. A BIDDING STRATEGY BASED ON A PROBABILISTIC ESTIMATION

We assume that all items are auctioned in English auctions that are held in some sequence. In addition, the auction of item X closes earlier than the auction of item Y. The expected clearing price of item Y is represented by a probability density function $f(y)$. There is a point at which a decision must be made on whether or not to continue bidding on X, and the final price of Y will be unknown at that point because of the above assumption. The profit gain of bidding on X over not bidding on X is represented as Z.

Firstly, the case for complementary goods is analyzed. We



(a) Complementary goods (b) Independent goods (c) Substitutive goods

Figure 1: Areas of profit in bidding on combinations of goods

assume that the total budget T is greater than the value of the combination X and Y, that is, $T > V_{xy}$. Given a current price x_1 for X, we can continue to bid on Y as long as $T - x_1 > y$. Therefore, when $V_{xy} - V_x > y$, the expected profit of getting both X and Y is

$$Z_1 = \int_0^{T-x_1} (V_{xy} - x_1 - y) f(y)\, dy \tag{1}$$

On the other hand, the expected profit of getting X but not getting Y is

$$Z_2 = \int_{T-x_1}^{\infty} (V_x - x_1) f(y)\, dy \tag{2}$$

As a result, the expected profit obtained by bidding on X at the price x_1 is calculated by using the next equation, in which α represents a risk premium, which is a parameter that expresses how conservative a bidder is in terms of taking risks.

$$\begin{aligned} Z_3 = & \int_0^{T-x_1} (V_{xy} - x_1 - y) f(y)\, dy \\ & + \int_{T-x_1}^{\infty} (V_x - x_1) f(y)\, dy \ - \alpha \end{aligned} \tag{3}$$

In some cases, the intermediate price of Y will be known, and this is referred to as y_1. In such a case, the probability density function $f(y)$ becomes $f_{y1}(y)$. The bidding on Y will result in a profit as long as the price y is in the range $y_1 < y < V_y$. Thus, the expected profit of getting Y (but not X) is

$$Z_4 = \int_0^{V_y} (V_y - y) f_{y_1}(y)\, dy \tag{4}$$

Therefore, the overall expected profit gain is expressed by the following two equations. When $y_1 < V_y$,

$$\begin{aligned} Z = & \int_{V_y}^{T-x_1} (V_{xy} - x_1 - y) f_{y_1}(y)\, dy \\ & + \int_{T-x_1}^{\infty} (V_x - x_1) f_{y_1}(y)\, dy \\ & - \int_0^{V_y} (V_y - y) f_{y_1}(y)\, dy \ - \alpha \end{aligned} \tag{5}$$

and when $y \geq V_y$,

$$\begin{aligned} Z = & \int_{y_1}^{T-x_1} (V_{xy} - x_1 - y) f_{y_1}(y)\, dy \\ & + \int_{T-x_1}^{\infty} (V_x - x_1) f_{y_1}(y)\, dy \ - \alpha \end{aligned} \tag{6}$$

When, for example, $f(y)$ is assumed to be uniformly distributed from a to b, the equation $Z = 0$ must be resolved for x_1. As long as the intermediate price y_1 is below $V_{xy} - V_x$, a bidder should bid on Y until $y < T$, since the profit obtained by getting both X and Y is always greater than the profit obtained by getting X alone, even when the total price $x + y$ exceeds the combined value V_{xy}. Therefore, as long as y_1 is lower than $V_{xy} - V_x$, it is possible to ignore the second terms of Equations (5) and (6). The following equations give the boundary $Z = 0$, at which the profit changes from positive to negative. When only $V_{xy} - V_x \leq y_1$ holds,
$V_{xy} - V_x \leq y_1$

$$x_1 = V_x - \alpha \tag{7}$$

and when both $V_{xy} - V_x > y_1$ and $T - x_1 \geq b$ hold,

$$x_1 = \frac{-b - y_1 - 2\alpha + 2V_{xy}}{2} \tag{8}$$

and when both $V_{xy} - V_x > y_1$ and $T - x_1 < b$ hold,

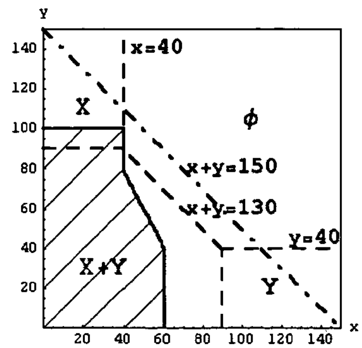


Figure 2: Bidding strategy using a probability model(complementary goods)

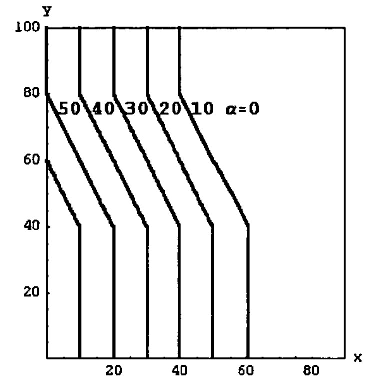


Figure 3: Bidding areas for various risk premium(complementary goods)

$$\begin{aligned} x_1 &= -b + T + V_x - V_{xy} + y_1 \\ &\quad + [b^2 - 2bT - V_x^2 + 2bV_{xy} + V_{xy}^2 \\ &\quad - 2V_xV_{xy} - 2bV_y + 2TV_y + 2V_xV_y \\ &\quad - 4V_{xy}V_y + 2V_y^2 - 2b\alpha + 2V_y\alpha]^{1/2} \end{aligned} \tag{9}$$

We are able to continue to bid on X as long as $x < x_1$, that is, while the price of X is lower than x_1. Figure 2 represents the region of positive expected profit for $a = 0$, $b = 100$, $V_x = 40$, $V_y = 40$, $V_{xy} = 130$, $T = 150$ and $\alpha = 0$. In the region defined by $V_{xy} - V_x > y_1$, the limit on bids for X decreases with increases in the intermediate price of Y. This is because it is becomes unlikely to get both X and Y within T at a given x when the price of Y increases.

Figure 3 represents the boundaries of possible bids for variable risk premiums. The limit on the bids decreases as the risk premium increases. This is because aversion to risk becomes higher for getting both X and Y without knowing the final price of Y.

Next, the equations that describe profit gain for bids on independent and substitutive goods are analyzed. For independent goods, the greatest profit is obtained by getting both items as long as the sum of the price of X and the price of Y is within the total budget T, so that the two cases $x_1 + y_1 \leq T$ and $x_1 + y_1 > T$ must be considered separately. The expected profit gains are expressed by the following equations. In the case of $x_1 + y_1 \leq T$,

$$\begin{aligned} Z &= \int_{y_1}^{T-x_1} (V_x + V_y - x_1 - y) f_{y_1}(y)\, dy \\ &\quad + \int_{T-x_1}^{\infty} (V_x - x_1) f_{y_1}(y)\, dy \\ &\quad - \int_{y_1}^{V_y} (V_y - y) f_{y_1}(y)\, dy \ - \alpha \end{aligned} \tag{10}$$

and in the case of $x_1 + y_1 > T$,

$$\begin{aligned} Z &= -\int_{y_1}^{V_y} (V_y - y) f_{y_1}(y)\, dy \\ &\quad + (V_x - x_1) - \alpha \end{aligned} \tag{11}$$

For substitutive goods, the expected profit gain is expressed by the following equation.

$$\begin{aligned} Z &= -\int_{y_1}^{V_y} (V_y - y) f_{y_1}(y)\, dy \\ &\quad + (V_x - x_1) - \alpha \end{aligned} \tag{12}$$

In the same way as for the analysis of profit maximization on complementary goods, it is assumed that $f(y)$ is uniformly distributed from a to b for Equations (10) to (12), then $Z = 0$ is resolved for x_1. Figures 4 and 5 represent the regions of profitable bidding at $a = 0$, $b = 100$, $V_x = 90$, $V_y = 90$, $T = 150$ and $\alpha = 0$ for the respective cases of independent and substitutive goods.

At $x_1 + y_1 < T$ in Fig. 4, the boundary curve of the expected profit gain will be shifted to the left of the dashed line by a result of clearing-price analysis such as $x = 90$, since this will decrease the likelihood of getting both X and Y and increase the loss of profit incurred by getting the single item X. At $x_1 + y_1 > T$ in Fig. 4, the boundary curve is shifted to the right of the dashed lines by the result of clearing-price analysis, since the price of Y is likely to increase later.

Figure 5 shows similar tendencies to Fig. 4. The boundary curve is shifted to the right of the dashed line by the clearing-price analysis in Fig. 1(c) since the price of Y would be likely to increase later.

Although the clearing price is assumed to be uniformly distributed for the purposes of this probabilistic analysis, other distributions, such as the normal distribution, produce similar tendencies to those that results from this analysis.

Bidding strategies that are likely to obtain a positive profit can be determined on the basis of the above analysis. The strategies differ for the three types of combined requirement for the goods.

Complementary goods:

1. Continue to raise the bid on X as long as the price remains within the area of the positive profit gain.

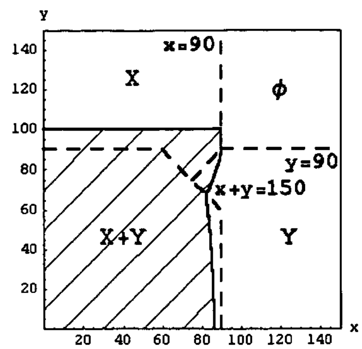


Figure 4: Bidding strategy using a probability model(independent goods)

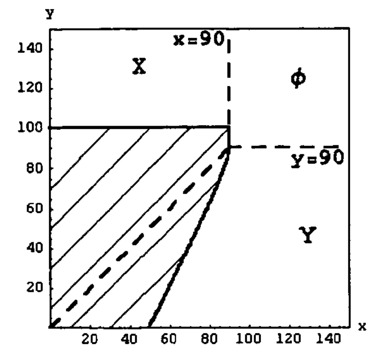


Figure 5: Bidding strategy using a probability model(substitutive goods)

2. If you win the auction of X, continue to bid for Y as long as the total price is within the budget.

3. If you lose the auction of X, stop bidding for Y.

Substitutive goods:

1. Bid on X as long as the price remains within the area of positive profit gain.

2. If you win the auction of X, stop bidding for Y.

3. If you lose the auction of X, continue to bid for Y as long as the price of Y is lower than value of Y.

Independent goods:

1. Bid on X as long as the price is within the area of positive profit gain.

2. If you win the auction of X, continue to bid for Y as long as the price of Y is lower than the value of Y and the total price remains within the budget.

3. If you lose the auction of X, continue to bid for Y as long as the price of Y is lower than the value of Y and within the budget.

4. EXPERIMENTS

4.1 Settings for experiments

This section reports on an evaluation of the proposed bidding strategy for a pair of complementary goods by simulation. Two simpler strategies and a strategy using dynamic programming developed by Boutilier are also evaluated as reference strategies. Four strategies were thus used in the evaluation, and they are briefly described below.

- Bids for items according to the strategy as proposed above on the basis of a probability model. (probability-based model or PB model).
- Bid for each item as long as its price remains below half of the value V_{xy} of the two items combined (even-division model or ED model).
- Intensively bid for the item in the first auction to close as long as its price remains below V_{xy}, then continue to bid on the other item as long as the total price remains within the budget (first-auction-intensive model or FI model).
- Apply an extended form of the dynamic programming for open-price auctions that was developed by Boutilier [2]. This strategy differs from the PB model in that bids are placed on each item without observing the item's current price. (dynamic-programming model or DP model).

In actual auctions, most bidders are bidding for single items rather than for combinations of items. In order to build a similar situation into the simulations, a further type of agent is introduced that bids for each item independently as long as its price remains lower than its value, that is, V_x or V_y.

Two types of experiments were used in the evaluation.

Experiment 1

One agent adopts one of the four combinational strategies given above and four agents independently bid for the two items, over two auctions. This experiment tests the performance of each strategy against agents that do not care about the combination of the two goods.

Experiment 2

Two agents each adopt one of the three strategies given above i.e., the DP model is not included and four agents bid for the two independent items, over two auctions. This experiment tests the correlation between results for the two strategic agents.

For the agents that are bidding for a combination of items, the parameters assigned are a total cost $T = 500$ and the

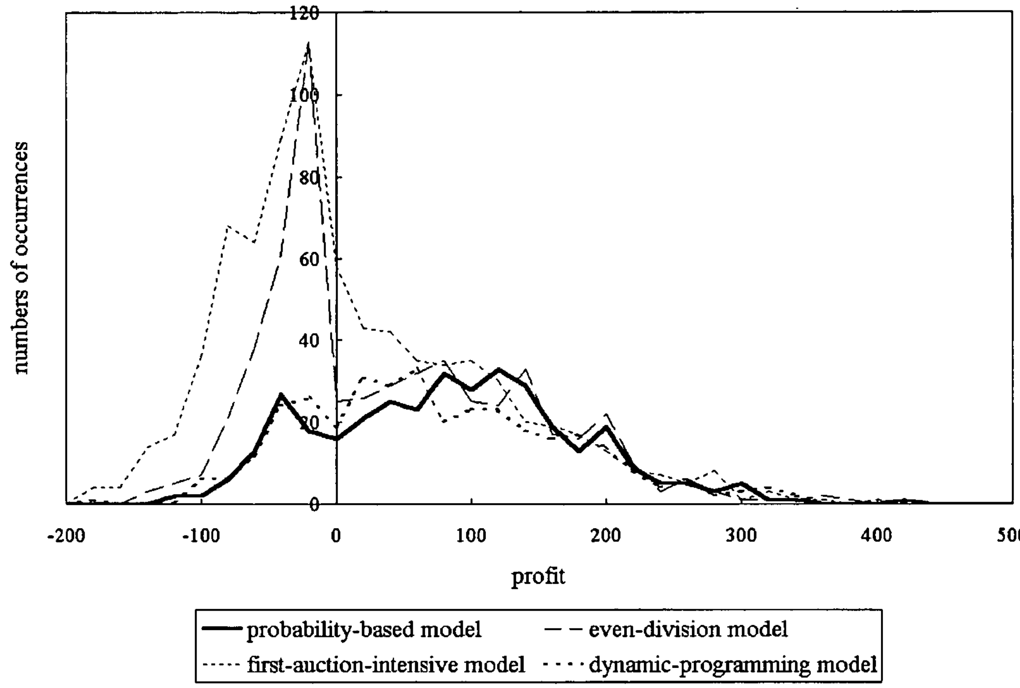


Figure 6: Distribution of profit

values of the individual items $V_x = V_y = 0$. The value of the combination of items V_{xy} is assigned a random value from 0 to 500. The expected clearing price is represented by a uniform distribution between $a = 0$ and $b = 250$. The total cost parameter assigned to the agent that is bidding for independent items is $T = 500$. V_{xy} is not assigned for these agents, since they do not care about the combination. Values for the items V_x and V_y are assigned with a probabilistic distribution, and the distribution of clearing prices for the four agents is uniformly distributed from a to b.

Two agents that strategically bid for combinations of items compete in experiment 2, so that, strictly speaking, the assumption of a uniformly distributed clearing price cannot work correctly, since the another strategic agent may win the auction and thus change the distribution of the clearing price. However, the another strategic agent has relatively little effect, since the four agents that are independently bidding for the items dominate the auctions. For this reason, we have ignored the changes made to the distribution by the other strategic agent.

4.2 Results of experiments

2000 experimental runs were carried out for each situation. Figure 6 shows the distributions of the profits obtained by the four types of strategic agents competing in Experiment 1. The horizontal axis represents the amount of profit and the vertical axis shows how many times the agents of the given types obtained the profit within the range of 20 wide. A negative profit occurs when the agent has won the first auction for X, but lost the second auction, so that the cost of its successful bid for X becomes a loss. The agent that applied the PB model had fewer cases of loss than the agents using the other strategies, and had more cases of greater profit than the other agents. Table 1 shows the average of profit for the agents that won the auctions, and the expected value of profit against all agents. Table 1 shows that the PB model is much better than the other models in terms of the average of profit when it wins. This is because the probability control manages the bidding very well, and avoids raising bids when the value of the combination is not very high. The expected value of profit of the PB model is also greater than that of the other models. On the other hand, the agent that uses the ED model wins many games with a small profit but also loses many games, and this results in poorer overall performance, since the strategy of trying to bid for both items within half of the value of the items combined is likely to win the auction of one item but lose the auction of the other. The agent that uses the FI model has the worst performance, since the agent intensively tries to win the first auction, and its remaining budget then becomes too small for it to win the second auction.

The expected profit for the DP model is also better than those for the ED and FI models, but is not as good as that of the PB model. The PB model is thus superior to the DP model.

This reflects, to some extent, the number of times items were won, as shown in Table 1. The PB model wins a single item the fewest times, while it wins both items as many times as the ED model. The FI model is the most frequent winner of both items, but is also the most frequent winner of a single item. The DP model wins both items fewer times

Table 1: Average and expected value of profit
One agent bidding for combinatorial goods and four agents bidding for independent goods

	average profit	expected profit	winning two items	winning one item
probability-based model	94.31	16.79	334	22
even-division model	51.42	14.40	352	208
first-auction-intensive model	23.99	9.48	575	215
dynamic-programming model	83.14	14.43	322	25

Table 2: Average and expected value of profit
Two agents bidding for combinatorial goods and four agents bidding for independent goods

	probability-based model	even-division model	first-auction-intensive model
probability-based model	101.46/13.93	102.45/13.73	83.93/9.86
even-division model	52.49/13.52	58.91/13.46	65.89/12.09
first-auction-intensive model	29.05/9.08	11.71/3.81	20.74/5.69

The contents of the cell are Average/expected value of profit

than the PB model, while the DP model wins a single item more often than the PB model.

Table 2 shows the result of Experiment 2, in which the correlations between results for strategies were observed. The rows in this table are the strategies that were examined. For example, the cell in the row of the PB model and the column of the ED model contains the average and expected value of profit for the agent applying the PB model, in competition with the agent applying the ED model. The highest expectatin of profit is seen in the cell that contains the profit of the agent applying the PB model in competition with the agent applying the PB model. For example, in the cell in the row of the FI model and the column of the PB model, the FI model may have changed its strategy to the PB model, if the agent were permitted to change its strategy. In this case, the expected profit of the agent applying the FI model improves from 9.08 to 13.93 when it is allowed to shift to the PB model. Figure 7 shows such strategy shifts. In this figure, the three numbers in the boxes indicate the expected profit for the PB, ED, and FI models, in that order. The arrows indicate shifts in strategy, and the agents finally reach a 'Two PB' competition. This result indicate that the strategy of the PB model is the equilibrium strategy of these three strategies.

5. DISCUSSION

Fujishima [4], Rothkopf [5], Sandholm [6, 7] and Varian [8] have researched auction mechanisms that assist bidders in bidding for combinations of items. These mechanisms are very useful, because the bidders need not care about winning one item but losing the other when they want both items but either item is worthless on its own. As a result, the bidders might get more profit at the auctions than if they did not use such combinatorial mechanisms. However, the determination of an optimal winner has been proven to be an NP-complete problem, although relatively efficient solvers have been proposed by Fujishima [4] and Sandholm [6, 7]. Moreover, actual auctions are held at various sites by various authorities, and it is hard to integrate bidding for auctions at such a variety of sites. Thus, as a probable solution, it is necessary to consider a strategy that allows a bidder to bid on items in sequential auctions according to his or her preference. The strategy proposed in this paper might result in a loss when a single item is obtained but the other is not, as was shown by the experiments. For players who want to avoid such risky bidding, we provide the parameter that represents risk premium, α.

Boutilier [2] has researched a similar situation to ours, in which the agents bid on items in sequential auctions so that they can get a combination of items. His research, however, was built around sealed-price auctions, and so his algorithm determines the exact bid price by which the expected profit will be maximized. This paper, on the other hand, has examined open-price ascending auctions, such as English auctions. In this situation, intermediate prices can be used to determine whether or not the next bid should be placed. We are going to examine the integration of both open- and sealed-price auctions in our bidding strategy.

As a further similarity, a probability model was used to estimate the clearing price in both this and Boutilier's work, and the probability model is a sensitive way of determining the price of the bid. Boutilier's research examines the incremental learning of a probability curve by iteration on similar auctions. This learning of probability will also be a subject of our work in the future.

6. CONCLUSION

This paper has described a bidding strategy that maximizes profit in bidding in multi-item auctions by using a probability model, and results for an autonomous agent that applies the model. Firstly, the possible combinations of requirements for multiple items were introduced, and then the regions in which a bidder can win the required combination of items were specified. Probabilistic analysis was then used to clarify the regions in which the bidder might win the required combination of items in sequential auctions. The proposed strategy for maximizing profit was evaluated by simulation, and the strategy outlined in this paper produced better performance than naive strategies, and was shown to be an equilibrium strategy.

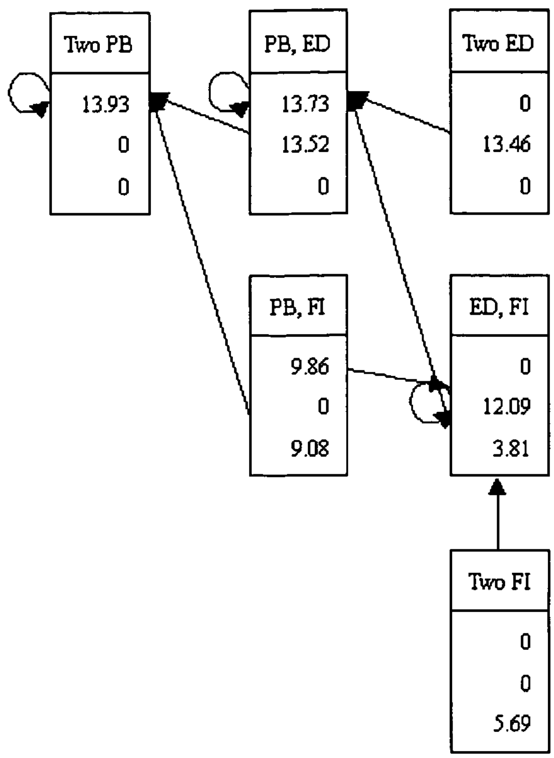


Figure 7: The shift to the equilibrium strategy

In actual markets, requirements for multiple items are frequently correlated with each other, but the items are separately traded. The more popular electronic commerce becomes, the more important combinatorial trading will become. We are going to take this research further to create more powerful agents for use with actual markets in the future.

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